Decision Rationale

Total Maximum Daily Load for
the Aquatic Life Use Impairment on the Guest River

I. Introduction

The Clean Water Act (CWA) requires a Total Maximum Daily Load (TMDL) be developed for those water bodies identified as impaired by a state where technology-based and other controls will not provide for attainment of water quality standards. A TMDL is a determination of the amount of a pollutant from point, nonpoint, and natural background sources, including a margin of safety (MOS), that may be discharged to a water quality-limited waterbody.

This document will set forth the Environmental Protection Agency's (EPA's) rationale for approving the TMDL for the aquatic life use (benthic) impairment on the Guest River. EPA's rationale is based on the determination that the TMDL meets the following eight regulatory conditions pursuant to 40 CFR §130.

1) The TMDL is designed to implement applicable water quality standards.
2) The TMDL includes a total allowable load as well as individual waste load allocations and load allocations.
3) The TMDL considers the impacts of background pollutant contributions.
4) The TMDL considers critical environmental conditions.
5) The TMDL considers seasonal environmental variations.
6) The TMDL includes a margin of safety.
7) There is reasonable assurance that the TMDL can be met.
8) The TMDL has been subject to public participation.

II. Background

The Guest River watershed is located in Wise, Scott, and Dickenson Counties, in Southwestern Virginia. The watershed is 64,244 acres in size and is composed of mostly forested lands. The TMDL addresses a 28.33 mile segment of the Guest River extending from its headwaters to its confluence with Bad Branch. The majority of the watershed is composed of forested lands (63%) other major land-uses include mine lands (16%), urban lands (14%), and agriculture (5%).

In response to Section 303(d) of the CWA, the Virginia Department of Environmental Quality (VADEQ) listed 28.33 miles of the Guest River (VAS-P11R) on Virginia's 1998 Section 303(d) list as being unable to attain the general standard for aquatic life and the primary contact uses. The primary

contact impairment was due to violations of the bacteriological criteria for fecal coliform. Monitoring data compiled since the 1998 Section 303(d) List, document the Guest River and two of its tributaries as currently attaining the bacteriological criteria for the primary contact use. As a result of the updated data, the primary contact use impairments (due to violations of the fecal coliform criteria) for these waters were removed from Virginia's 2002 Section 303(d) List and TMDLs are no longer needed. Tributaries that were assessed as still failing the bacteriological criteria will have TMDLs developed in the future. The failure to attain the general standard for aquatic life use was determined through biological assessments of the benthic macroinvertebrate community. This decision rationale will address the TMDL for the impairment of the aquatic life use.

Virginia 305(b)/303(d) guidance states that support of the aquatic life use is determined by the assessment of conventional pollutants (dissolved oxygen, pH, and temperature); toxic pollutants in the water column, fish tissue, and sediments; and biological evaluation of benthic community data.[1] Therefore, a biological assessment of the benthic community can be used to determine a stream's compliance with the state's general standard for aquatic life use. Virginia uses EPA's Rapid Bioassessment Protocol (RBPII) to determine the condition of a stream's benthic macroinvertebrate community.[2] This approach evaluates the benthic macroinvertebrate community between a monitoring site and its reference station. Measurements of the benthic community, called metrics, are used to identify differences between monitored and reference stations.[3]

Reference stations are established on streams which are minimally impacted by humans and have a healthy benthic community. Streams that are classified as moderately or severely impaired after an RBPII evaluation are classified as impaired and are placed on the Section 303(d) list of impaired waters. During the 1996 and 1998 assessment periods, the Guest River was evaluated as being moderately impaired and only partially supporting its aquatic life use.

RBPII assesses the condition of the macroinvertebrate community of a stream. This analysis will inform the biologist if the stream's benthic community is impaired. However, it will not inform the biologist as to what is causing the degradation of the benthic community. A degraded community is generally seen as having a lower family diversity composed of species from pollutant tolerant families. Additional analysis is required to determine the pollutants which are causing the impairment. TMDL development requires the identification of impairment causes and the establishment of numeric endpoints

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[1]VADEQ. 1997. 1998 Water Quality Assessment Guidance for 305(b) Water Quality Report and 303(d) TMDL Priority List Report. Richmond, VA.

[2]Tetra Tech 2002. Total Maximum Daily Load (TMDL) Development for Blacks Run and Cooks Creek. Fairfax, Virginia.

[3]Ibid 2

that will allow for the attainment of designated uses and water quality criteria.[4] For the Guest River, VADEQ biologists conducting the benthic assessments in the watershed determined that the benthic community was impacted by excessive sedimentation. Excess sediment negatively impacts the benthic community by filling pools and interstitial spaces between gravel and sand which provide habitat for many benthic macroinvertebrates. Excess sediment can also clog an organism's gill surfaces and decrease its respiratory capacity. Lastly, the turbidity created by excess sediment can hinder a visual predator's ability to hunt and feed thus providing additional stress on the organism.

Toxicity testing was conducted for water samples collected in the Winter of 2002 from the Guest River. The tests compared the survival and reproduction rates of fathead minnows (*pimephales promelas*) and *Ceriodaphnia Dubia* in water collected from the impaired sites with the survival and reproduction rates of these same species in waters from an unimpaired source. The test did not document any acute effects to the survival of fathead minnows or *Ceriodaphnia Dubia* reared in water from the Guest River. However, subchronic effects on the growth of fathead minnows were observed in water from the Guest River but the differences were too small to be considered biologically significant.

To develop a sediment TMDL, it was necessary for the Commonwealth to devise a numeric sediment loading that would insure the attainment of the aquatic life use since the Commonwealth does not currently have water quality criteria for sediment. The Commonwealth used a reference watershed approach to determine the pollutant endpoint for the TMDL. Numeric endpoints represent the water quality goals that are to be achieved through the implementation of the TMDL and will allow a stream to attain its designated uses. A reference watershed approach is based on selecting a non-impaired watershed that shares similar land use, ecoregion, and geomorphological characteristics with the impaired watershed.[5] The stream conditions and loadings in the reference stream are assumed to be the conditions needed for the impaired stream to attain standards.

To determine whether a stream was a suitable reference site for the monitored sites, the modelers evaluated the topography, soils, ecoregion, and landuses of the potential reference watershed. By definition, the reference must score slightly impaired or better in the biomonitoring analysis. The reference site selected was Burns Creek, which is located in the Washington National Forest and is within the Guest River watershed. The watershed is nearly entirely forested (97%) and supports a healthy aquatic assemblage. Since the pollutant/stressor was identified as sediment, sediment loading to the reference and impaired watersheds was determined and then an allocation that would lower the impacted watershed's loading to the level observed in the reference was created.

Table 1 - Summarizes the Specific Elements of the TMDLs.

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[4]Ibid 2

[5]Ibid 2

Segment	Parameter	TMDL (lbs/yr)	WLA (lbs/yr)	LA (lbs/yr)	MOS (lbs/yr)
Guest River	Sediment	9,635.63	317.52	9,318.21	Implicit

The United States Fish and Wildlife Service has been provided with a copy of the TMDL.

III. Discussion of Regulatory Conditions

EPA finds that Virginia has provided sufficient information to meet all of the eight basic requirements for establishing an aquatic life use (benthic) impairment TMDL for the Guest River. EPA is therefore approving this TMDL. Our approval is outlined according to the regulatory requirements listed below.

1) The TMDL is designed to meet the applicable water quality standards.

The Guest River watershed was listed as impaired due to a degradation of the benthic macroinvertebrate community. As mentioned above, benthic assessments inform the biologist of an impairment, but they are unable to identify a stressor. However, the biologists were able to identify a stressor, excess sediment loading, for this watershed based on a review of ambient water quality monitoring data and field observations within the Guest River. Virginia does not have numeric criteria in place establishing the appropriate sediment loading to a stream. Therefore, a reference watershed approach was used to identify the appropriate sediment loading rate. The loading rate obtained from the reference watershed was used as the TMDL endpoint. It believed that if this loading rate is obtained, the impairment to the benthic community will be removed.

The Commonwealth used updated land use data and specific land use runoff equations in order to determine the sediment loadings to both the impaired and reference watersheds. Aerial photographs of the watershed were taken in March 2001. Color infrared (CIR) film was used for the aerial photography. Due to its sensitivity to the near infrared portion of the light spectrum, CIR provides the interpreter with information that is not normally part of the visible spectrum of the human eye. The interpreter is able to make a better assessment of the vegetative cover because the Chlorophyll of plants is highly reflective of near infrared. Thirty-two land-uses were identified from the aerial photography data. These land-uses were then aggregated into ten land-use types. The ten land-uses were urban land, crop land, pasture land, forest land, active strip mine, tipples, previously mines land, disturbed areas, wetlands, and open water. The area for each land-use was determined and was vital for determining the sediment loading to the Guest River watershed. The sediment load for the Guest River watershed was determined via the process described below. After the determination of the existing load, the model was adjusted to provide the equivalent sediment loading rate to the Guest River as was observed in Burns Creek.

2) The TMDL includes a total allowable load as well as individual waste load allocations and load allocations.

Total Allowable Loads

Virginia indicates that the total allowable loading is the loading derived from applying the reference watershed loading rate to the entire Guest River watershed. The total allowable loading contains the sum of the loads allocated to land based precipitation driven nonpoint source areas (forest and agricultural land segments) and point sources. Activities that increase the levels of sediment to the land surface or their availability to runoff are considered flux sources. The actual value for total loading can be found in Table 1 of this document. The total allowable load is calculated on an annual basis.

Waste Load Allocations

There are 66 regulated point source dischargers within the watershed. Twenty-five of these dischargers are mining facilities, 35 are small family home facilities, two are stormwater facilities, two are minor industrial facilities, two are minor municipal facilities, and one is a major municipal facility. None of these facilities had their effluent limits reduced as a result of the TMDL. Tables 3.1 and 3.2 of the TMDL report document the WLAs for each of these facilities in tons/year.

EPA regulations require that an approvable TMDL include individual WLAs for each point source. According to 40 CFR 122.44(d)(1)(vii)(B), "Effluent limits developed to protect a narrative water quality criterion, a numeric water quality criterion, or both, are consistent with assumptions and requirements of any available WLA for the discharge prepared by the state and approved by EPA pursuant to 40 CFR 130.7." Furthermore, EPA has authority to object to the issuance of any National Pollutant Discharge Elimination System (NPDES) permit that is inconsistent with the WLAs established for that point source.

Load Allocations

According to Federal regulations at 40 CFR 130.2(g), load allocations (LAs) are best estimates of the loading, which may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting loading. Wherever possible, natural and nonpoint source loads should be distinguished.

Six equations were used to determine the sediment loading to the stream from the various land-uses. Table 2 documents the load allocations for all land-uses. For determining the sediment loading to the Guest River from urban lands, Equations 1 and 2 were used. Several of the parameters associated with these equations were urban land-use specific. For instance although the same rainfall amount was used for all urban lands, the runoff coefficient, sediment concentration value, and percent imperviousness were changed based on whether the urban land was considered residential,

commercial, developed, industrial, transportation, or major highway. Therefore, the model produced different loadings for different types of urban lands.

Equation #1

$$M = RainV \times Rv \times Area \times Conc \times 0.0001135$$

Where:

M	=	mass load (tons)
RainV	=	rainfall amount inches
Rv	=	runoff coefficient
Area	=	drainage area (acres)
Conc	=	average sediment concentration in runoff (mg/L)
0.0001135	=	unit conversion factor

Equation #2

$$Rv = 0.050 + 0.009(PI)$$

Where:

Rv	=	runoff coefficient
PI	=	percent imperviousness derived from aerial photography

For non-urban lands, a different set of equations were used. Equations 3, 4, and 5 were used to determine the sediment loading from agricultural, forested, and mined lands. Once again the land-uses were further refined and parameters were adjusted based on these refinements to get a more accurate sediment loading to the Guest River. The pollutant load generated in Equation 3 was used in Equation 4 to determine the sediment loading to the Guest River.

Equation #3 Revised Universal Soil Loss Equation (RUSLE)

$$A = R \times K \times LS \times C \times P$$

Where:

A	=	soil loss (tons/acre/year)
R	=	rainfall energy factor
K	=	soil erodibility factor
LS	=	slope length factor
C	=	cropping management factor
P	=	erosion control practices factor

Equation #4

$$M = A \times Area \times DR \times PC$$

Where:

M	=	pollutant loading (tons/year)
A	=	soil loss (Equation 3)
Area	=	land class area
DR	=	delivery ratio
PC	=	pollutant coefficient

Equation #5

$$DR = 0.417768 \times (A^{-0.134958}) - 0.127097$$

Where:

DR	=	delivery ratio
A	=	watershed area

Equation 6 was used to determine the sediment load to the Guest River watershed from beef cattle and horse operations. For additional information on any of these equations, please refer to Appendix D of the report.

Equation #6

$$M = NA \times WT \times PR \times 0.0001825 \times DR \times NSn$$

Where:

M	=	pollutant loading
NA	=	number or animals
WT	=	animal weight
PR	=	pollutant production rate
0.0001825	=	unit conversion factor
DR	=	delivery ratio
NSn	=	number of sites of type n

Table 2 - Load Allocations for all Land-Uses in the Guest River Watershed.

Land Use	Existing TSS Load (Tons/yr)	Percent Reduction	Allocated Load (Tons/yr)
Urban Land	4,666.6	56%	2,038.1
Crop Lands	7.3	0%	7.3
Pasture Lands	1,641.9	60%	662.4
Forest Lands	4,535.7	2%	4,447.06
Active Strip Mine	17.8	0%	17.8
Tipples	1,323.1	90%	134.15
Previously Mined Land	5,181.8	77%	1,199.9
Abandoned Mine Features	1,943.8	100%	0.0
Disturbed Areas	781.8	70%	234.5
Stream Banks	331.1	50%	165.5
Livestock Access Areas	8.3	0%	8.2
Unimproved Roads	802.2	50%	401.1
Total	21,241.4	56%	9,315.4

3) The TMDL considers the impacts of background pollution.

Background pollutant contributions were considered in the modeling process by quantifying the sediment load delivered from forested lands.

4) The TMDL considers critical environmental conditions.

According to the EPA regulation 40 CFR 130.7 (c)(1), TMDLs are required to take into account critical conditions for stream flow, loading, and water quality parameters. The intent of this requirement is to ensure that the water quality of the Guest River is protected during times when it is most vulnerable.

Critical conditions are important because they describe the factors that combine to cause a violation of water quality standards and will help in identifying the actions that may have to be undertaken to meet water quality standards[6]. Critical conditions are a combination of environmental

[6]EPA memorandum regarding EPA Actions to Support High Quality TMDLs from Robert H. Wayland III, Director, Office of Wetlands, Oceans, and Watersheds to the Regional Management Division Directors, August 9, 1999.

factors (e.g., flow, temperature, etc.), which have an acceptably low frequency of occurrence. In specifying critical conditions in the waterbody, an attempt is made to use a reasonable "worst-case" scenario condition. For example, stream analysis often uses a low-flow (7Q10) design condition because the ability of the waterbody to assimilate pollutants without exhibiting adverse impacts is at a minimum. These critical conditions ensure that water quality standards will be met for other than worst case scenarios. Since there is usually a significant lag time between the introduction of excess sediment into a system and its detrimental effects, the use of average annual conditions as determined in this model is appropriate.

5) The TMDLs consider seasonal environmental variations.

Seasonal variations involve changes in stream flow as a result of hydrologic and climatological patterns. In the continental United States, seasonally high flows normally occur in early spring from snow melt and spring rain, while seasonally low flows typically occur during the warmer summer and early fall drought periods. The model accounts for seasonal variation in rainfall and vegetative cover in the RUSLE.

6) The TMDLs include a margin of safety.

This requirement is intended to add a level of safety to the modeling process to account for any uncertainty. The MOS may be implicit, built into the modeling process by using conservative modeling assumptions, or explicit, taken as a percentage of the WLA, LA, or TMDL. Virginia included an implicit MOS in the Guest River TMDL by using Burns Creek to represent the reference condition. Burns Creek is located in a national forest and over 95% of its watershed is made up of forested lands. The sediment loadings associated with this Creek are in all probability more restrictive than needed.

7) There is a reasonable assurance that the TMDL can be met.

EPA requires that there be a reasonable assurance that the TMDL can be implemented. WLAs will be implemented through the NPDES permit process. According to 40 CFR 122.44(d)(1)(vii)(B), the effluent limitations for an NPDES permit must be consistent with the assumptions and requirements of any available WLA for the discharge prepared by the state and approved by EPA. Furthermore, EPA has authority to object to issuance of an NPDES permit that is inconsistent with WLAs established for that point source.

Nonpoint source controls to achieve LAs can be implemented through a number of existing programs such as Section 319 of the CWA, commonly referred to as the Nonpoint Source Program.

The TMDL in its current form is designed to meet the applicable water quality standards. The Commonwealth intends to implement this TMDL through best management practices (BMPs). The implementation of these practices will occur in stages. This will allow the Commonwealth to monitor the benefits of the BMPs and determine which practices have the greatest impacts on water quality. It

will also provide a mechanism for developing public support and checking the accuracy of the model.

8) The TMDLs have been subject to public participation.

A preliminary meeting was held on April 19, 2001 to discuss the TMDL process with the Guest River Restoration Group. A public meeting was noticed on October 8, 2002 and held on October 16, 2002 at the Tacoma Community Center. Approximately 30 people attended the public meeting. The thirty-day comment period commenced after the meeting.